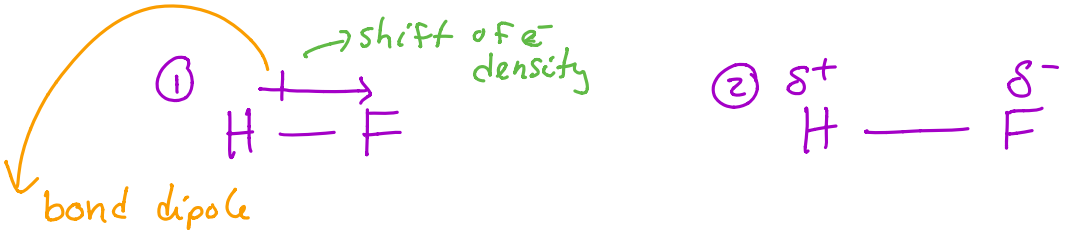
SCH4U – Lesson 8

Polarity and Intermolecular Forces

Bond Polarity

- Recall that electronegativity is the ability to attract an electron
- Bond polarity refers to the ___distribution___ of electron density amongst the bonded atoms:
  - A covalent bond is polar when the electronegativity is between 0.4 and 1.7.
  - The most electronegative atom will exert a ___greater___ pull on the shared electrons, shifting the electron density towards it.



Molecular polarity

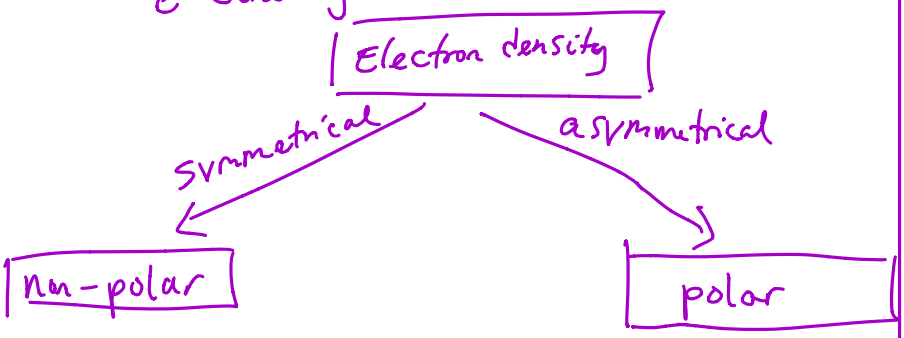
- Molecular polarity refers to the distribution of electron density amongst the atoms that make up a molecule.
- Factors determining the polarity of a molecule:
  1. Molecular shape, particularly symmetry.
     - Symmetric: Electron density is ___evenly___ distributed around the molecule
     - Asymmetric: electron density is ___not evenly___ distributed about the molecule
  2. Bond polarity.

- Assessing the polarity of a molecule:

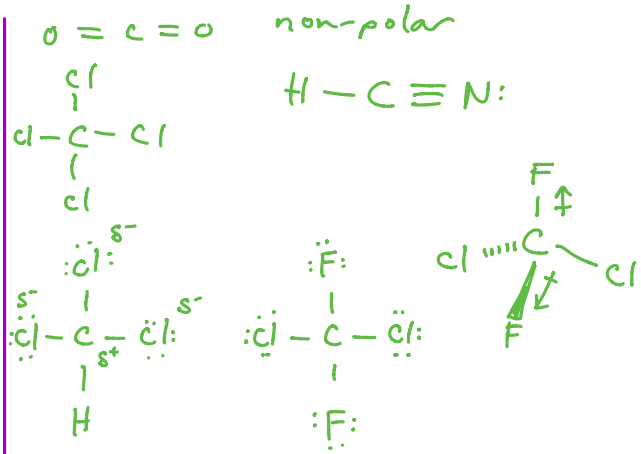
① Find the shape of the molecule

② Examine the bond dipole

③ Examine distribution of e⁻ density.



H - Cl



Intramolecular forces

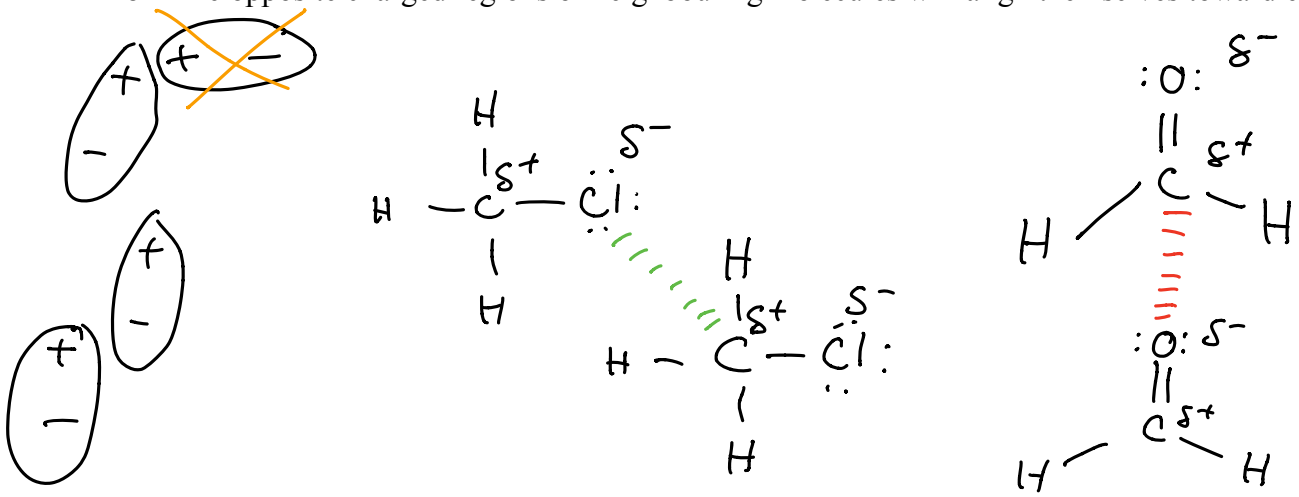
- Intramolecular forces: forces within a molecule
- Three types of intramolecular forces:

Ionic, covalent, metallic bonding.

Intermolecular forces

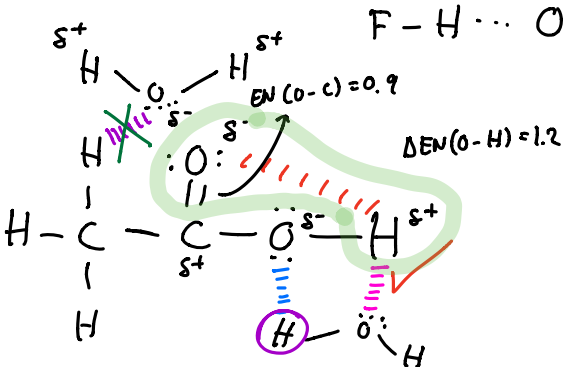
- ~~Intra~~Inter molecular forces: forces between molecules

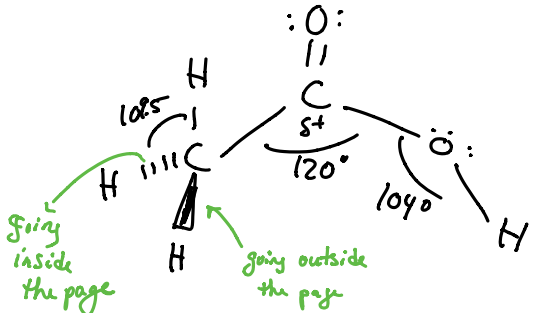
- Dipole-Dipole:
  - Present when region in the molecule has a permanent partial negative charge and another region has a permanent partial positive charge.
  - The opposite charged regions of neighbouring molecules will align themselves toward each other.



- Hydrogen bonding (dipole-dipole)
  - A specific dipole-dipole interaction that is stronger than the other intermolecular forces.
  - Happens between a H that is bonded to a highly electronegative atom (ex: N, O, F) and a highly electronegative atom on a neighbouring molecule.
  - What enhances the dipole-dipole force here is the lone pairs on the electronegative atoms.

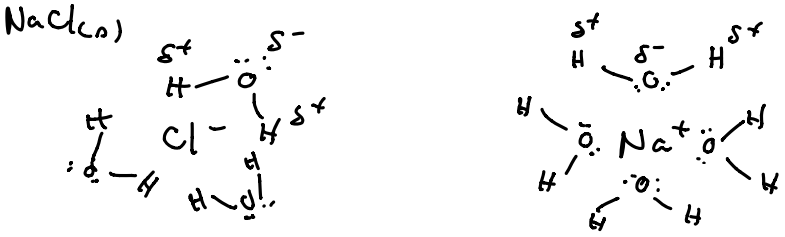
Possibilities: O–H···O or O–H···N or O–H···F
N–H···O or N–H···N or N–H···F
F–H···O or F–H···N or F–H···F



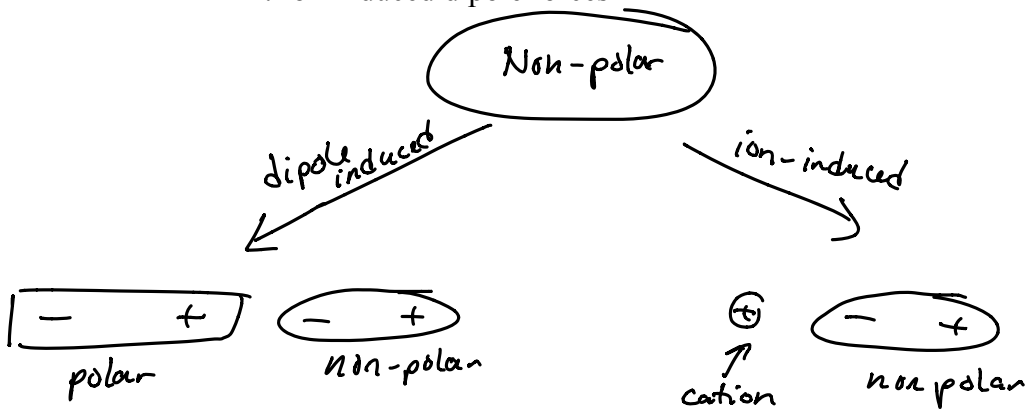


- Ion-dipole
  - The electrostatic attraction between ions and dipoles.
  - Strength depends on: 1. charge and size of ion and
    2. magnitude of dipole and size of molecule

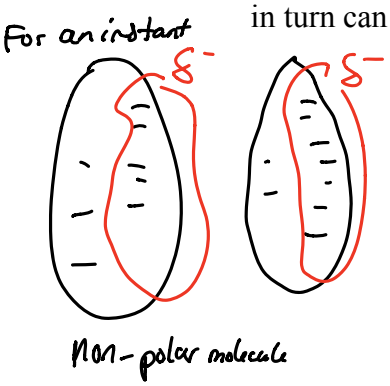
Ex: hydration



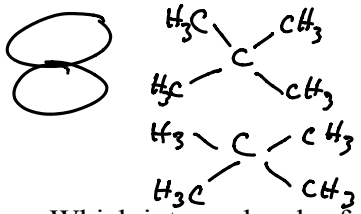
- Induced dipole forces:
  - Formation of a dipole in a non-polar molecule.
  - Distorted electron distribution (only for a brief instant, not permanent)
  - Two types: 1. Dipole-induced dipole forces
    2. Ion-induced dipole forces

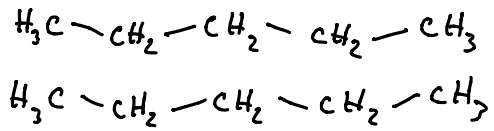


- Dispersion forces (London forces):
  - Present in all molecules, but: the only attractive force *between* non-polar molecules.
  - Non-polar molecules form temporary dipoles: shared electrons are in constant motion
    - Temporary dipole will induce a dipole on other neighbouring non-polar molecules, which in turn can induce a dipole on another neighbouring non-polar molecule (and so on).



- Two factors affect the magnitude of these forces:
  - (1) Mass (increase of electrons, thus more likely to have a temporary dipole)
  - (2) Surface area (is the area of contact big – think sphere or linear shape)





I_2 v.s Br_2

I_2 → nonpolar → has more $\vec{e}$

Br_2 → nonpolar → Br less $\vec{e}$ than I

- Which intermolecular forces can be present in:

Between Polar molecules
- dipole dipole
- H-bond (stronger than dipole-dipole)
- london dispersion forces
- ion dipole

Between non-polar molecules CCl_4
- london dispersion forces
- induce dipole

* short lived displacement : instant

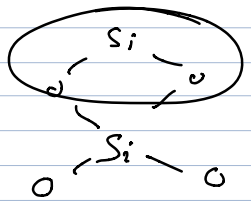
Properties of Polar Covalent Molecules

- Intermolecular forces stronger than those of nonpolar covalent compounds due to the presence of dipoles.
- Polar covalent molecules:
  - tend to have __high__ melting points and boiling points.
  - are more likely to be __solid__ ~~and~~ or __liquid__ at room temperature.
  - will dissolve in polar solvents if hydrogen bonds are present.
  - will __not__ conduct electricity to an appreciable degree (some can ionize in solution)

Properties of Non-Polar Covalent Molecules

- Low melting and boiling points. (generally)
- Given the low intermolecular forces that exist in nonpolar molecules:
  - tend to have __low__ melting and boiling points.
  - they are usually __gas__ at room temperature.
  - soluble in __non-polar__ solvents.
  - will __not__ conduct electricity.

Covalent network solids

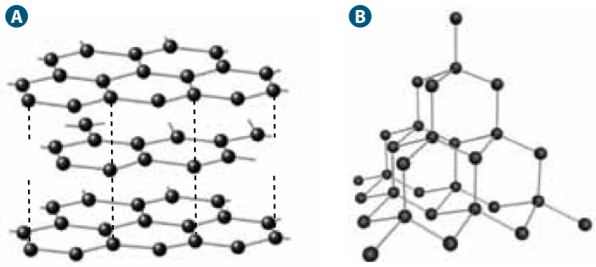


- Atoms bonded covalently.
- No beginning or end
  ↳ "they don't contain molecules"
- Example: carbon diamond, graphite

allotropes: different forms

- Properties: ↑ melting and boiling point

  Generally hard and non-conductive
  (exception graphite)



graphite diamond